

Optimization of Grade Change Process for Minimization of Down Time:

By:

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Abstract:

The present work shows how critical path method (CPM) can be successfully implemented to reduce the time required for system wash-up during grade changes. It has been observed that after implementation of CPM activities, there was a reduction of more than 50-60% downtime for grade change.

Introduction:

Unlike many paper machines in developed countries, grade change is very common in Indian mills. Though, many experts are of the opinion that grade changes should be avoided as it is wastage of time and resources (as a lot of inputs are wasted during the grade change process), yet, many mills are interested in making different grades of paper just due to economic reasons on a single paper machine. In this way, for mills producing different grades of paper on a single machine, quality change costs some additional amount that has to be reduced in order to be competent enough to stay in the market.

Present Practices:

We can differentiate grade changes in three categories- GSM Change, without any colour or furnish or shade change; furnish or shade change, with or without GSM change where changes are minor and trace amounts of previous furnish does not affect the next quality significantly; and furnish or shade change, with or without GSM change where changes are minor and trace amounts of previous furnish severely affects the next quality. Where only the GSM has to be changed, there is not much problem, and speed changes along with change in basis weight valve opening or steam pressure set point changes can solve the problem. On some machines, GSM fluctuation can occur during a grade change, but earlier work by the author¹⁻³ shows how such problems can be solved.

In case of furnish or shade changes, normally, system is drained, filled with water again and machine is started up with new furnish. If there is a doubt that previous shade and affect the next quality, the system is drained, filled with water and restarted with water only, for a couple of minutes, drained again, refilled with water, and then started. This obviously takes longer time. On a typical paper machine, the time was to the tune of 1.5-2 hours. As the mill started receiving smaller orders, and longer runs were not possible due to delivery and other constraints it became necessary to optimize grade changes for quicker and faster grade changes.

Methodology:

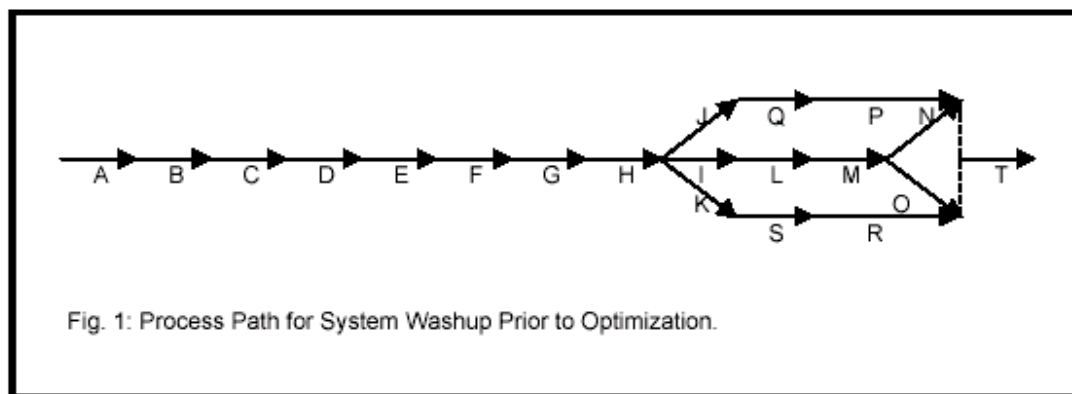
Critical path method is a commonly used technique for project optimization where different tasks are to be completed and some of these are dependent on others. For example, if 10 jobs are to be done to complete a project, the maximum time required by the project would be sum of time required for each job. Similarly, the minimum time required to finish the project would be the maximum of time required by an individual job, provided all jobs are independent. But, in practical cases, some jobs are dependent on others, as in our case, we cannot fill backwater silo with fresh water if it has not been drained and cleaned properly.

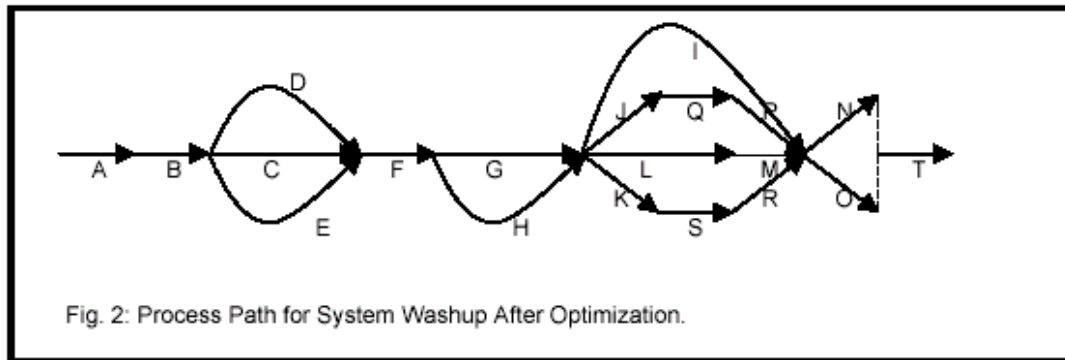
The use of critical path method was implemented and all the activities were assigned different codes (alphabets).

Let us see in detail, what happens during a grade change with furnish change-

Activity	Code (Time)
• Stop machine chest agitator.	A (0.5)
• Stop machine chest pump.	B (1.5)
• Stop Vacuum Pumps.	C (0.5)
• Stop Tertiary Centricleaner Pump.	D (0.5)
• Stop Secondary Centricleaner pump.	E (0.5)
• Stop Fan Pump.	F (0.5)
• Stop Pressure Screen.	G (0.5)
• Stop Vibrating Screen.	H (0.5)
• Drain Back Water Silo.	I (12)
• Drain primary centricleaner pit.	J (5)
• Drain secondary centricleaner pit.	K (4)
• Using hose, clean hydra foils, back water channels, etc.	L (8)
• Clean Back Water silo using water hose.	M (5)
• Fill water in Back Water Silo.	N (11)
• Close Silo Drain Valve.	O (0.5)
• Fill water in Primary centricleaner pit.	P (5)
• Close Primary centricleaner pit drain valve.	Q (0.5)
• Fill water in Secondary centricleaner pit.	R (4)
• Close secondary centricleaner pit drain valve.	S (0.5)
• Start approach flow in usual fashion.	T (13)

In this method, we plot a diagram showing each activity with an arrow, starting each subsequent activity from the head of its previous activity. The initial diagram looks like as given in fig.1. If we compare the same with Fig.2, i.e. the plot after optimization, we find that there is a great potential for washing time minimization. As indicated by the figures, the time saved by optimization was to the tune of 15-20 minutes.





Another washing related problem was soon noticed just while the analysis of grade change process started. It was found that while the backwater silo was being drained off, one person started cleaning the walls of the same using hose pipe. Having done that, he turned to wire table, and started cleaning table interiors, hydrafoils, etc. By this time, silo was empty and clean, but had to be cleaned again using hose as slime detached from foils etc. had entered in silo. Obviously, the correct practice would have been to clean wire table while the silo is being drained, and then clean silo, followed by water filling process. Paper machine crew was described in detail with correct washing sequences, illustrating above example, and observed reduction in system wash-up time afterward.

Further Improvements:

The critical path method also indicates further optimization opportunities in this area. If we consider fig. 3, we find that there are some activities, where a faster operation can be done to further reduce the time required for system washing. In fig.3, activities A, B, C, D are some of activities the time of which can be reduced easily. Following actions were taken for the same-

1. A second drain line in backwater silo was provided to reduce time in silo draining to 4.5 minutes.
2. A second fill line to back water silo using a separate pump was provided, to reduce filling time to 5 minutes.
3. Incorporating a practice to drain backwater silo just before switching off the machine chest pump to save 0.5 minutes in emptying backwater silo.
4. Incorporating a practice to start fan pump even when backwater silo is only 75% full. This saves nearly one minute, without affecting approach flow performance, as backwater silo fills up before wet web is taken to press part.

The above actions resulted in a direct saving of nearly 10 minutes, without much of investment or efforts. Additionally, installation of motorized or pneumatically operated valves is being planned for drain and fill locations, to further save 2-2.5 minutes. The proposed system can later be interlocked with solenoid valves and timers to automate the draining-filling process.

Critical Quality Changes:

The common practice with critical quality changes such as from blue poster to yellow poster, the normal trend in the mills is to make yellow poster first, so as to minimize loss in system washing. But in case it has to be done, normally, system is drained, washed, filled with water and started again with water only for a couple of minutes, drained again, and the cycle is repeated. This obviously is a more time consuming procedure, and there exists a need to look for a more time efficient process for such changes. For the same, some modifications were made in approach flow system-

1. Secondary centricleaner accept was taken to a separate decker mounted over machine chest, with thick stock to machine chest, or drained for a while during the grade changes. This eliminated need to clean primary centricleaner reject pit simultaneously with system washing. Now, system can be washed up without considering PCC reject pit, and while water is being filled in silo, PCC reject pit is drained. This way, load on mill drains is reduced, or alternatively silo can be drained much faster if its drain valve needs to be throttled in case of overloading of mill drains. Having done that, PCC reject pit is filled with water, and PCC pump is started. As the decker is already being drained, we can get centricleaner system properly washed within less time. Secondary and tertiary centricleaner systems are also cleaned in the same way.
2. It was observed that some of dyes are neutralized with certain chemicals. A detailed analysis of different dye containing water (coloured backwater) was made and cleaning was limited to partially draining, filling with water, addition of dye remover chemicals and then draining reduced the quality change time significantly. In a typical test case, quality change from deep blue poster (match box) to post office red poster was completed within 14 minutes (paper to paper). Use of hypo has been tried and found very useful in some furnishes.
3. Couch broke, which was earlier being taken to decker thickner and then to a separate broke chest was directed to machine chest. By doing so, quality was not affected as the machine very good machine runnability, and hence the quantity of couch broke is very less. Provision was also made to drain the couch broke from near the machine chest. During a quality change, water is filled in couch pit, and is pumped to drain in order to quickly and efficiently drain couch pit.
4. A separate tank was provided to hold the back water, with a separate pump from backwater silo and associated piping. This helped in reduction on sudden loading of mill drains and hence flooding in machine area. The water contained in this tank is drained later on as and when possible, without creating shock loads on mill drains and ETP.
5. Automation process is being implemented with PLC control to speed up the process. As only timer based control is required, the total cost of implementation is very less, to the tune of rupees two lacs only. With an estimated 5-9 minute saving in each quality change and washing process, this amount is expected to have a payback of approximately 6 months only.

Conclusion:

From the above, it is clear that quality change time can be easily reduced by a significant value. The basic approach is to reschedule all operations involved, to minimize time taken by individual operations, and to automate the system washing /draining procedures.

References:

1. Singhal, D.K., "Cross Direction Profile Unstability: Evaluation & Correction", IPPTA 14(1):35(2002)
2. Singhal, D.K., "Optimization of Approach Flow for GSM Control", IPPTA, Convention Issue: 99 (2003)
3. Singhal, D.K., "Modeling & Simulation of Approach Flow for GSM Control", IPPTA J., 17(1): 75(Jan. 2005)